Urological emergency: diagnosis and management of renal trauma

Renal trauma can be a life-threatening emergency and, because of its rarity, knowledge of its recognition and management is limited. This review discusses the clinical diagnosis, classification of injury, management and complications of this emergency condition.

Renal trauma is often missed in the acute setting primarily because of the location of the kidneys, which are protected anteriorly by abdominal viscera and posteriorly by musculature and the spine. Undetected renal trauma can be catastrophic and even fatal. Renal injuries are commoner than expected with an estimated 245 000 cases occuring throughout the world per year (Santucci et al, 2004). In the UK, they account for approximately 3% of trauma admissions and occur in up to 10% of patients with acute abdomen following trauma.

Renal injuries rarely occur in isolation, with 95–100% of all major renal injuries being accompanied by injuries to other organ systems (McAninch et al, 1993). It is therefore crucial that an appropriate history is elicited and that the clinician is experienced in interpreting examination findings, in order to guide further investigations. The management of renal trauma has changed over time and the current trend of managing most blunt traumas, including the most seriously injured, is towards non-operative management. Selective penetrating renal injuries are also shifting from immediate surgical exploration to a more conservative approach (Santucci et al, 2004).

Diagnosis

History

A high degree of clinical alertness is essential in making a diagnosis of renal injury. The mechanism of injury is important in that it provides the framework for clinical assessment and subsequent treatment. Ninety per cent of renal injuries in the UK result from blunt trauma, most commonly caused by road traffic accidents, fall from a height or assault. Rapid vehicular deceleration can cause renal vascular damage and subsequent renal artery thrombosis, renal vein disruption or renal pedicle avulsion (Rosen and McAninch, 1994). Penetrating renal injuries most often arise from gunshot and stab wounds to the upper abdomen or lower chest (Nicol and Theunissen, 2002). Iatrogenic renal injuries may occasionally result from extracorporeal shock-wave lithotripsy, endourological procedures, renal biopsy and percutaneous renal procedures (Fukumori et al, 1997). Therefore, in the history it is important to establish the nature and mechanism of the injury, presenting symptoms, and any other co-morbid factors.

Typically, the patient may complain of loin pain, loss of left lateral abdominal flexion, loss of contour and frank haematuria. Pre-existing disease such as renal cysts, hydronephrosis, tumour, stones and ectopic locations has been associated with higher incidence of damage as a result of blunt trauma, especially in the paediatric population (Schmidlin et al, 1998).

Examination findings

Other associated injuries should be detected on primary survey (life threatening) and on secondary survey (limb threatening). Loin haematoma and tenderness are the most sensitive signs of underlying pathology.

Investigations

All trauma patients should have urgent full blood count, urea and electrolytes and group and save of serum, as well as a full trauma series as necessary (lateral c-spine, chest and pelvic films) to exclude co-existing injuries. Baseline tests specific for renal trauma should include urinalysis for haematuria. Although dipstick positive haematuria is very sensitive for renal trauma, its absence does not always exclude injury – in 36% of renal vascular injuries arising from blunt or penetrating trauma, haematuria was absent (Nicol and Theunissen, 2002). Therefore, the degree of haematuria and severity of renal injury do not necessarily correlate. In addition, it is important to differentiate between haematuria and fresh bleeding per urethra, as the latter denotes lower urinary tract injury and requires completely different management.

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Table 1. American Association for the Surgery of Trauma's (AAST) Organ Injury Scaling Committee

Grade I	Renal contusion with microscopic or gross haematuria, urological studies normal Subcapsular haematoma, not expanding with no parenchymal laceration
Grade II	Perirenal haematoma, not expanding and confined to renal retroperitoneum Laceration <1 cm parenchymal depth of renal cortex without urinary extravasation
Grade III	Laceration >1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation
Grade IV	Laceration through the cortex, medulla and collecting system Main renal artery or vein injury with contained haemorrhage
Grade V	Laceration resulting in a completely shattered kidney Avulsion of the renal hilum devascularizing the kidney

Advance one grade if injury is bilateral, up to grade III. From Santucci et al (2001) and http://www.aast.org/injury/injury.html

Radiological investigations are central to the definitive management of renal trauma. There are four main objectives of imaging:

1. To grade the injury (*Table 1*)
2. To identify injuries to other intra-abdominal organs such as bowel, pancreas, liver and spleen
3. To assess function of the opposite kidney
4. To recognize any pre-existing pathologies of the injured kidney.

Evidence suggests that stable patients with blunt trauma and microscopic haematuria and those without frank haematuria do not require imaging at any stage, unless there is deterioration in their clinical condition during observation (Santucci et al, 2004).

Patients presenting following blunt trauma with gross haematuria, or microscopic haematuria with a systolic blood pressure less than 90 mmHg any time during evaluation and resuscitation, should undergo emergency renal imaging. Penetrating injuries in a stable patient with any degree of haematuria should also undergo expeditious imaging. Computed tomography (CT) with intravenous contrast is the imaging investigation of choice, and has replaced the old practice of obtaining a routine intravenous urogram (IVU) in all individuals with major trauma. The reasons for this are that CT allows accurate assessment of the renal parenchyma and collecting system injuries. Lack of contrast enhancement of the parenchyma often indicates an arterial injury. CT is also sensitive for medial haematomas suggestive of vascular injury, and medial urinary extravasation indicative of renal pelvis or ureteropelvic junction avulsion.

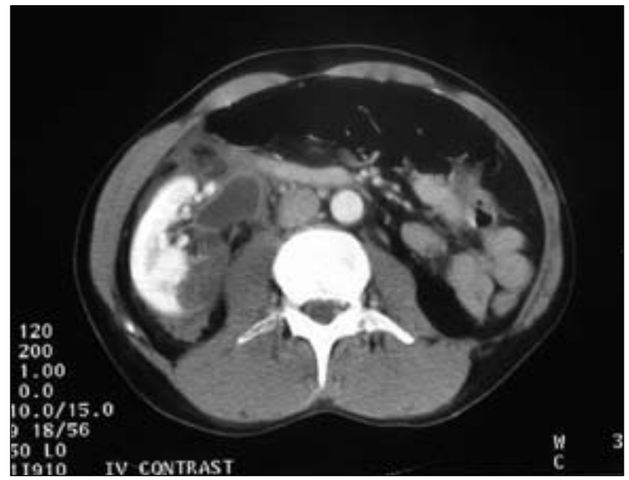
Other imaging modalities are considered adjunctive. For example, arteriography has been used to define arterial injuries (Heyns and van Vollenhoven, 1992), and ultrasound scan (USS) is used because of its ease of use in the accident and emergency department. USS allows a quick assessment of any retroperitoneal haematoma, and confirms the presence or absence of two kidneys (Pinto and Chimeno, 1998). However, the significant limitation of USS is its inability to delineate parenchymal lacerations, vascular or collecting system injuries. In a study comparing USS and CT scans in assessing polytrauma, USS missed several renal injuries (McGahan et al, 1997). USS is useful, however, in following up patients with postoperative fluid collections, renal lacerations managed conservatively and hydronephrosis. Magnetic resonance imaging using gadolinium-based contrast media may be used in patients with iodine allergy.

Importantly, obtaining radiological investigations should under no circumstances delay operative intervention on a critically injured unstable patient (Stevenson and Battistella, 1994).

Management

Initial management of any renal trauma victim must adhere strictly to Advanced Trauma and Life Support (ATLS) guidelines (American College of Surgeons, 1997). Secondary management is dependent on the type and grade of the injury sustained. Of renal traumas 85%

Figure 1. Computed tomography scan showing lack of contrast enhancement posteromedially in the kidney, indicating contusion in a grade I injury. Note this patient also has a hydronephrosis of his solitary kidney.



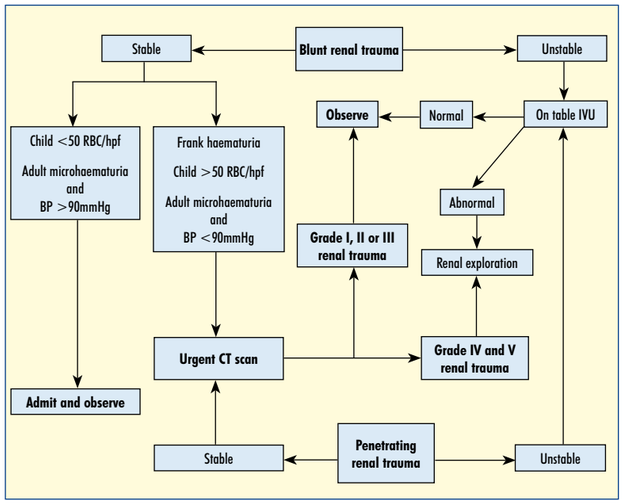


Figure 2. Algorithm for management of renal trauma. Based on Santucci et al (2004). BP = blood pressure; CT = computed tomography; hpf = high powered field; IVU = intravenous urogram; RBC = red blood cells.

are minor contusions (*Figure 1*), 10% are major injuries and only 5% are critical (pedicle injury or renal fragmentation) (Nicol and Theunissen, 2002).

Grade I, II and III injuries usually involve haemodynamically stable patients. These patients can be managed conservatively with bed rest, analgesia, antibiotics, rehydration, CT scan and then serial USS without renal exploration (*Figure 2*). Grade IV (*Figure 3*) and V injuries often require surgical exploration; this is absolutely indicated by evidence of persistent renal bleeding, expanding and pulsatile perirenal haematoma. In addition, all unstable patients with blunt or penetrating trauma require emergency midline laparotomy to confirm the diagnosis and assess coexisting intra-abdominal injuries (*Figure 2*). If radiological imaging is necessary, a 'one-shot' IVU may be obtained during surgical exploration to quickly assess the function of the contralateral kidney. When surgical intervention is necessary, all efforts should be made to salvage the damaged kidney. There should be sufficient renal exposure for debridement of non-viable tissue, haemostasis by individual ligation of bleeding vessels, impervious closure of the collecting system, and coverage or approximation of the defect. Nephrectomy is only immediately indicated in extensive renal injuries when the patient's life would otherwise be threatened and current literature indicates a 38% decrease in the incidence of nephrectomy (Santucci et al, 2004).

More relative indications for surgical exploration include urinary extravasation, non-viable tissue, delayed diagnosis of arterial injury, segmental arterial injury and incomplete staging. However, evidence suggests that even these may be managed conservatively, unless the clinical condition deteriorates (Santucci et al, 2004).

Figure 3. Grade IV injury of the right kidney, with a laceration through the cortex, medulla and collecting system and leakage of contrast. Also note the perirenal haematoma on this side and a normally perfused left kidney.

Complications

Urological complications following renal trauma can be divided into early (*Table 2*), those occurring within 4 weeks of injury and delayed complications.

Urinary extravasation leads to urinoma formation, which can give rise to a palpable swelling, ileus and a low-grade fever. However, 80–90% of the urinomas resolve and can be managed conservatively. Infection of a pre-existing haematoma, or a urinoma, can lead to perinephric abscess formation. The incidence is increased in presence of devitalized tissue, injury to the colon, pancreas or septic focus such as infected central lines. Percutaneous drainage under imaging with appropriate use of antibiotics is the preferred method of management. A search should be made for continuous leak of urine from the pelvicalyceal system and treated with an indwelling ureteric stent. Secondary haemorrhage as a result of infection is common in major laceration injuries especially following penetrating wounds. It is most often caused by rupture of a pseudoaneurysm or an arteriovenous fistula.

Table 2. Early and late complications after renal trauma

Early complications	Urinoma formation	Simple urinoma
		Infected urinoma
	Secondary haemorrhage	
	Infection	Perinephric abscess
		Systemic sepsis
	Vascular complications	Arteriovenous fistula formation
		Pseudoaneurysm
		Hypertension
Late complications	Page kidney – hypertension as a result of scar formation	
	Hydronephrosis	
	Calculus formation and chronic pyelonephritis	

From McAninch (1996)

A conservative approach is successful in the majority of patients with selective arterial embolization being reserved for prolonged bleeding. Post-traumatic renovascular hypertension is an uncommon complication following renal trauma. The possible factors responsible for hypertension include renal artery occlusion, renal artery stenosis with or without intimal flap, renal artery compression, severe renal contusion, arteriovenous fistula, pseudoaneurysm formation or chronic contained subcapsular haematoma. Excess renin secretion as a result of renal ischaemia has been shown to be responsible for hypertension.

A chronic contained subcapsular haematoma and perirenal scarring create a compressive force on the deformed kidney, reducing the blood flow into the kidney and initiating renin-induced hypertension. This is known as Page kidney, named after Dr Irvine H Page, who first demonstrated in 1939 that wrapping cellophane tightly around animal kidneys produced hypertension. Delayed complications are more common in patients with a devascularized segment who are managed conservatively (Husmann et al, 1993).

Conclusions

In the first instance, renal trauma requires strict adherence to ATLS guidelines; furthermore, awareness of the possible presence of renal injury is imperative and considerable attention should be given to the grade of renal trauma. There is an abundance of diagnostic modalities available for imaging, but it seems that contrast-enhanced CT scan is the gold standard. In patients with haemodynamic instability and high grade injury, surgical exploration remains the treatment of choice. Evidence suggests a trend towards less invasive methods of trauma management, particularly in patients with low-grade injuries, blunt trauma and in selected cases of penetrating trauma. Endourological manipulation and interventional radiology have also augmented the capacity to effectively care for patients without the need for surgery. **BJHM**

Conflict of interest: none.

American College of Surgeons (1997) *Advanced Trauma Life Support (ATLS) for doctors.* 6th edn. American College of Surgeons, Chicago

Fukumori T, Yamamoto A, Ashida S et al (1997) Extracorporeal shock wave lithotripsy-induced renal laceration. *Int J Urol* **4:** 419– 21

Heyns CF, van Vollenhoven P (1992) Increasing role of angiography and segmental artery embolization in the management of renal stab wounds. *J Urol* **147:** 1231–4

Husmann DA, Gilling PJ, Perry MO, Morris JS, Boone TB (1993) Major renal lacerations with a devitalised fragment following blunt abdominal trauma: a comparison between nonoperative (expectant) versus surgical management. *J Urol* **150:** 1774–7

McAninch JW (1996) Renal injuries. In: Gillenwater JY, Grayhack JT, Howard SS, Duckett JW, eds. *Adult and Pediatric Urology.* 3rd edn. Mosby, St Louis, Mo: 539–53

McAninch JW, Carroll PR, Armenakas NA, Lee P (1993) Renal gunshot wounds: methods of salvage and reconstruction. *J Trauma* **35:** 279–84

McGahan JP, Rose J, Coates TL, Wisner DH, Newberry P (1997) Use of ultrasonography in the patient with acute abdominal trauma. *J Ultrasound Med* **16:** 653–62

Nicol AJ, Theunissen D (2002) Renal salvage in penetrating kidney injuries: a prospective analysis. *J Trauma* **53:** 351–3

Pinto IT, Chimeno PC (1998) Treatment of a urinoma and a post-traumatic pseudoaneurysm using selective arterial embolization. *Cardiovasc Intervent Radiol* **21:** 506–8

Rosen MA, McAninch JW (1994) Management of combined renal and pancreatic trauma. *J Urol* **152:** 22–5

Santucci RA, McAninch JW, Safir M et al (2001) Validation of the American *Association for the Surgery of Trauma organ injury severity scale for* the kidney. *J Trauma* **50:** 195–200

Santucci RA, Wessels H, Bartsch G et al (2004) Evaluation and management of renal injuries: consensus statement of the renal trauma subcommittee. *BJU Int* **93:** 937–54

Schmidlin FR, Iselin CE, Naimi A et al (1998) The higher injury risk of abnormal kidneys in blunt renal trauma. *Scand J Urol Nephrol* **32:** 388–92

Stevenson J, Battistella FD (1994) The 'one-shot' intravenous pyelogram: is it indicated in unstable patients before celiotomy? *J Trauma* **36:** 828–34

KEY POINTS

- Renal trauma is on the increase with the increase in road traffic accidents and war casualties.
- Resuscitation according to Advanced Trauma and Life Support guidelines should precede any investigations.
- A computed tomography scan with intravenous contrast is the investigation of choice.
- Grade I, II and III injuries can be managed conservatively, whereas grade IV and V renal trauma may require surgical intervention.
- Delayed complications are known to occur and therefore the patient may need a long follow up.